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Designing an undergraduate module in Asset Management

A D Crossley¹, Dr S Male²

¹ Senior Teaching Fellow, University of Bristol, UK Andrew.Crossley@Bristol.ac.uk
² Visiting Fellow, University of Bristol, UK

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Abstract

The paper describes the planning, design and structure of a new module in Asset Management to be delivered from January 2015 at a major UK university. The module, termed a ‘Unit’, is an option for final year MEng students as part of their Engineering Council’s Accredited Higher Education Programme. The authors plan to follow up with a ‘lessons learned’ paper in 2015.

1 Introduction

Asset Management (AM) optimises the effective and efficient management of physical assets as an organisational resource. It is an overarching organisational capability. It acts as an interface between organisational strategy, and, the strategic, tactical, operational management and use of physical assets to enable organisational functioning over time [1]. Hence, it integrates the business and technical capabilities of an organisation to achieve the whole life management of its physical asset base.

1.1 Global Infrastructure

Physical infrastructure represents national systems that include roads, railways, ports, airports, power, water and telecommunications [2]. Two estimates for global infrastructure investment provide a sense of scale in terms of the importance of the managerial need for asset management. A first estimate notes that in the order of US$40 trillion of investment will be required globally in new and existing physical infrastructure between 2007 and 2030 [3,4]. A more recent figure from the McKinsey Global Institute (MGI) places that estimate higher at US$57 trillion within the same end date [5]. The MGI report notes that its figure is approximate but represents the levels of investment required to keep pace with projected global growth in GDP. By any measure those figures are substantive. However, aggregate levels of investment are dispersed, prioritised and implemented through a myriad of individual organisations. This sets up a global requirement for increased levels of asset management capability - a need that occurs at an organisational, team and individual level.

1.2 National Infrastructure

The UK Government’s National Infrastructure Plan (NIP) 2010 noted that for several decades the UK’s approach to infrastructure investment has been hesitant, uncoordinated, incremental, and uneconomic in its procurement [6]. The consequence is an ageing and costly infrastructure with an unclear future plan. The UK Government’s Comprehensive Spending Review (CSR), covering the period to 2014-15, argues there could be substantial gains to be made from a more coordinated approach to AM across the public sector [7]. In May 2011 the UK Government introduced its Strategy for Construction [8], which acknowledges the important relationship between Asset, Project and Programme Management delivery. This clearly relates AM to the management of investment delivery processes. The Strategy adds that the integration of the design and construction of an asset with its operational phase should lead to improved asset performance. Hence, this links decisions on procurement within part of a broader asset life cycle decision structure rather than it being seen as just a stand-alone process.

More recently, the Institution of Civil Engineers (ICE) in their recent State of the Nation report highlighted three infrastructure sectors requiring close attention from policymakers and industry, namely energy, flood management and local transport. In addition to the foregoing, the ICE also concluded that the approach to delivering and maintaining infrastructure requires attention generally, adding further that the ‘future proofing’ of water, waste and strategic transport also requires attention in order to transition the UK to a low carbon economy and to meet the needs of society and the environment [9]. In December 2013 the Chief Secretary to the Treasury launched an updated National Infrastructure Plan outlining the Government’s strategy for meeting the UK’s infrastructure needs up to and beyond 2020 [10]. NIP 2013 also provides for an infrastructure pipeline representing some £375 billion of public and private investment [11].

In sum, asset management will continue to be at the forefront of international and UK infrastructure investment and delivery for decades to come.

1.3 Role of the Higher Education Sector

Within this international and national context, the Higher Education (HE) sector provides a major potential resource covering research, education, recruitment and future developments within Asset Management as an emergent professional discipline. There is a very close alignment between those disciplines seen as ‘professions’ and the university sector [12]. This sets the environment within which Asset Management needs to be positioned within the HE sector
and the strategic context for the development of a Unit in AM at a Russell Group university [13].

1.4 The Need for Blended Learning

The authors’ combined backgrounds cover over four decades’ experience in AM including a combination of senior roles in major utilities and their engineering subsidiaries, the design and leadership of AM business units, the design of academic and commercial training and development programmes, research, consultancy, and Masters level course design and leadership at UK Russell Group universities. This mix of the practitioners’ and educators’ perspectives, built on strong institutional level partnership between industry and academia, informed the need for the scope, design and assessment of the proposed Unit. The Unit is therefore designed to be delivered by Asset Management practitioners, researchers and educators to create the next generation of AM professionals who are positioned to respond to the growing needs identified in national and international infrastructure highlighted above.

2 The Design, Structure and Positioning of an Asset Management Unit

A Masters in Engineering (MEng) degree is a Level 7 Qualification. At an Engineering Council (EC) accredited university it is typically delivered over either four or perhaps five years, depending on whether the undergraduate spends a ‘year out’ working in a relevant industry.

In late 2013 a review of the final year options available for engineering students at a Russell Group university identified the potential to create a new multi-disciplinary Unit capable of attracting candidates from across the engineering disciplines in the Faculty. At the University a Unit is a 10 credit module representing approximately 8% of a year’s full time study, or the equivalent of 100 hours of dedicated study. Several possible alternatives were considered by members of the programme planning and delivery community within the Faculty. However, the increasing momentum to ensure high levels of undergraduate engagement, post graduate employability and practical competence influenced the decision to create a final year Unit in Asset Management. The Faculty approved its scope in January 2014 for initial delivery between January and June 2015.

The University’s Engineering Faculty’s Programme Learning Outcomes (PLO) requirement for Intellectual Development at Level 7/Masters is summarised as follows:

“Much of the study undertaken at Masters’ level will have been at, or informed by, the forefront of an academic or professional discipline. Students will have shown originality in the application of knowledge, and they will understand how the boundaries of knowledge are advanced through research. They will be able to deal with complex issues both systematically and creatively, and they will show originality in tackling and solving problems. They will have the qualities needed for employment in circumstances requiring sound judgement, personal responsibility and initiative, in complex and unpredictable professional environments.”

These are demanding requirements that exceed the knowledge, current focus and application of the Level 6 or Bachelor in Engineering (BEng) degree. These additional requirements for the final year, that differentiate between a Level 6 and Level 7 qualification, mean any new Unit needed to balance leading edge practices with excellent judgement and professionalism.

2.1 Philosophy behind the Unit

To meet the University’s Unit accreditation the designers needed to agree and state the Intended Learning Outcomes (ILOs). These had to follow the Faculty’s required PLOs but tailored to the core learning goals of the Unit. As professional practitioners, educators and examiners, the designers were also keen to create as much alignment as possible to the subject matters covered within the 5 core modules of the Institute of Asset Management’s (IAM) Professional Certificate qualification as a relevant benchmark.

As institutional proponents of AM, one challenge was to assess the potential developments within the IAM’s curriculum that may come into play by mid-2015. As highlighted in the introduction, the professional world of AM is a fast moving and dynamic environment working at the interfaces of business strategy, decision making, lifecycle activities, asset information, organisation and people, risk and review, and, in many situations legislation and strong regulation. Therefore the new Unit’s Intended Learning Outcomes (ILOs) were created to reflect the combination of the key competencies needed from future Asset Managers and the capacity and capability of Unit’s delivery team. The ILOs were defined by the Faculty as follows:

1. Understand and apply the key principles of Asset Management.
2. Identify engineering activities required to promote and contribute to asset development.
3. Understand and analyse basic asset and related investment performance indicators.
4. Understand and apply the principles of asset health monitoring and condition-based maintenance.
5. Understand the framework of relevant legal requirements governing asset condition.
6. Apply integrated management systems for health, safety, environment and quality.
7. Treat asset knowledge and innovation as business assets.
8. Appreciate the need for a high level of professional conduct in Asset Management.

This is a robust listing of requirements and therefore needed the mix of industry practitioners, researchers and academia to be able to deliver the Unit as an integrated team.

2.2 Design of the Unit – The Why

Experience with related management and technical Units from second and third year levels of the MEng programme at the University highlighted the enthusiasm of students for real world case material. They are keen to engage with expert practitioners who have high credibility and a passion for their subject. Passion creates student enthusiasm and the thirst to
learn more about the subject. Hence the Faculty has embedded very strong industry links over many years, highlighting the strength of this collaboration as part of its ethos. Many senior practitioners contribute and/or lecture to undergraduates and postgraduates as part of the University’s integrated partnership between industry and academia. The AM Unit has been designed to reinforce this ethos.

2.3 Curriculum

The Unit is designed on the basis of 100 hours of study, broken down into two broad domains: ‘Delivery’ through lectures, group work and computer labs; and ‘Personal Study’ comprising reading, written work, and preparation for and taking assessments. Key topics covered in the Unit are:

1. The principles of Asset Management. AM as a system, its integration with other management systems and the organisational strategic plan.
2. The concepts of asset management as set out in the ISO55000 series of standards.
3. Asset condition and performance assessments including structural health monitoring, condition-based maintenance and linkages to the University’s ‘Smart Cities’ initiative.
5. Quantitative techniques for whole life costing (acquire, use, maintain and renew or dispose) and decision support tools.
6. The structure and regulation of the infrastructure industries.
7. Practical implication of AM planning for health and safety management and environmental protection.
8. Professional competence and the roles of the professional institutes in Asset Management.

Formal teaching and learning on the above topics will be complemented by talks from practitioners from the water, rail, airport, highways, energy and process industries. The Unit’s core texts are Lloyd’s two books on Asset Management [14] and International Case Studies in Asset Management [15], the ISO 55000 series of standards [16], the International Infrastructure Management Manual [17], the Asset Management Landscape 2nd Edition [18], IAM’s Anatomy of Asset Management 2nd Edition [19], the CIRIA Handbook on Whole Life Infrastructure Asset Management [20] and a variety of relevant IAM and industry reference publications.

2.4 Assessment Methods

It was determined that student assessment shall use two approaches. Each is worth 50% of the Unit i.e. the equivalent of 5 credits each. The two approaches are:

1. Group Project. Working in teams of four students, teams will be expected to critically compare and contrast two published Asset Management Plans (AMPs) against an AM template and the principles of ISO55000. The expectation is that their assessment will identify the strengths and weaknesses of the assigned AMPs and consequently propose areas for improvement. AMPs will be selected from organisations such as rail, road, marine, energy, water, sanitation and government bodies, using publicly available information for case material. In addition, the teams will be required to test the AMPs, potentially against the IAM’s Self-Assessment Methodology (SAM) tool or other diagnostic and assessment techniques, in a computer laboratory exercise to help inform their analyses.

2. Examination. Students will be assessed at the end of the module by a formal 2 hour university examination.

2.5 Delivery Methods

The Unit will be delivered in the second semester of the 2014/15 academic year. It will start in January 2015. In line with its design scope, the Unit will be delivered through a combination of topical and technical lectures, case studies, computer labs, group work and the final examination.

Delivery will comprise of two ‘back to back’ lectures per week. The process will typically be:

1. Set reading from the Unit’s core texts including the International Case Studies [15]. The subject matter will be linked to the subsequent lecture. For example, students will read Chapter 2 of Lloyd about Dublin Airport Authority before a lecture is delivered by an external speaker from Heathrow Airport’s AM team.
2. Delivery of a themed one hour lecture from an Asset Management expert. Students will be invited to ask relevant questions to abstract as many practical learning points as possible from the lecture.
3. The external lecture is linked to a second hour’s follow on lecture about a related subject area, typically drawn for the IAM’s Competence Framework listing [21]. For example, lifecycle management, asset upgrade and replacement (of highways and bridges).

3 The Challenges of Developing the Unit

Scoping, planning and delivering a new MEng Unit represented a significant investment for a university. It had a series of approval gates to navigate as well as ensuring the content was married to the PLOs and ILOs. It also needed to address a range of requirements from professional institutions to ensure compliance with the Engineering Council’s UK Specification for Higher Education [22]. Compliance with UK-SPEC is critical for the University’s HE accreditation status, keeping it amongst the leading Universities teaching Engineering.

3.1 Initial Constraints and Risk

Teaching fifty students was considered the practical limit for any new Unit to be delivered as an option. This limit was set to ensure the Unit was of a manageable size and to limit teaching delivery risks in its first year of operation. It has also been designed for use as a dedicated Unit in a taught post
graduate programme. By September 2014 fifty students had already signed up for the Unit, which was its inaugural limit.

More students wanted to join the Unit. This bodes well for future years and demonstrated the high levels of undergraduate interest in AM. After delivering the Unit in the first half of 2015 it will be subject to the relevant quality management review. Following a successful review it should be possible to allow up to 100 students to take the unit, including a wider range of departments from the Faculty. This would represent about 20% of the year group.

Engineering courses are very popular with undergraduates and postgraduates studying at the University and the Faculty is expanding as part of a planned growth strategy to cater for this high demand. The University is providing new laboratories, growing the academic research and teaching teams, and expanding its physical facilities to cater for the increase in numbers. In turn, this investment will benefit the Unit’s delivery.

3.2 Assessment against the IAM Competency Framework

It was initially proposed that the University adopted the IAM’s Professional Certificate examination as part of the assessment process. This is a 2 hour computer based test on the IAM’s five mandatory Professional Certificate modules. However, the following practical and governance challenges were raised:

1. **Timeliness.** The IAM exam uses external test centres and their schedules would be unlikely to coincide with the University’s strict final examination timetables.

2. **Content.** The Unit is not using exactly the same teaching materials and approach as the IAM Certificate and other MEng degree units had already covered key topics such as risk planning and management. Students would not appreciate being examined twice on the same topics.

3. **Governance.** The IAM requires both institutional and/or individual Associate membership as a prerequisite to sitting the Certificate. The University reviewed this constraint in May 2014 and for governance reasons decided it was not in a position to require its students to join any professional body, even though it encourages this. This is a governance constraint.

4. **Outsourcing Risk.** The University could not accept the principle of outsourcing its own certified examination structures and procedures for Quality Control reasons. This is not a quality/technical comment about the IAM’s excellent Professional Certificate but a short to medium term risk based constraint, driven by compliance requirements within the University.

5. **Common Question Sets.** The IAM Professional Certificate uses a random selection of module questions from an established and regularly refreshed Question Bank. Therefore each IAM candidate can have different questions drawn from the five mandatory modules. The nature of the marking, grading and audit systems of the University requires a common set of questions be provided to candidates.

3.3 Degree of Alignment

As stated, the Unit required alignment with the Engineering Council’s UK-SPEC for HE Institutions and the aim of the Unit was to give students an introduction into the whole life management and stewardship of physical infrastructure. Therefore one of the primary challenges in designing the Unit was deciding on the extent and nature of alignment with a combination of relevant professional institutions. The IAM’s maturing approach to professional development gave the Unit designers a good starting position.

The IAM has a well-regarded Competencies Framework, a Professional Certificate and Diploma. It is also working towards chartered institutional status. One of the first points of possible high level Unit validation was the extent of the alignment between the principles underpinning the new Unit and the IAM’s Competences Framework. The validation of those principles and the Unit’s content against the Competencies Framework are set out in Table 1.

4 Conclusions

Asset Management is and will continue to be an essential corporate capability in future decades. The paper has presented the design, development and delivery methods for a dedicated AM Unit within a Level 7 Master of Engineering degree at a Russell Group University.

The new Unit is targeted at addressing the multidisciplinary needs at national and international levels that were identified by the development team in the management of physical assets through their life cycle. Students taking the new Unit will be seeking employment in those national and international organisations at the front line of making important investment decisions, procuring, designing, constructing or managing physical assets. They therefore need to have an understanding of the requirements of the emergent AM discipline. This has to include how engineering design, maintenance and operation sits within a broader managerial emphasis on managing physical assets throughout their life cycle.

A key principle behind the design of the Unit, and its delivery, is the engagement from the outset with industry and government experts in AM. The Unit’s design ensures that their input occurs at important stages throughout the delivery cycle.

This is linked to wider reading and team-based project work on AM, and importantly relating that to the good practices, standards and guidance that already exist. Whilst the Unit is an option, it is highly probable it may well influence those students in their final year project work or dissertations.

The Unit represents a significant investment by the University in the topic of AM. That investment has already been rewarded by a high level of interest for the first group who have enrolled for the Unit beginning in 2015. There is a clear expectation within the Unit team that those initial levels of interest will grow significantly over the coming years.
The design and principles behind the Unit have been validated against the IAM’s Competencies Framework, with the high level mapping presented in the paper. The Unit design will shortly be tested in practice from January 2015.

The intention is to present a paper at next year’s joint IET/IAM conference on the outcomes of that delivery. This will also include a detailed benchmarking of the Unit content against a wider group of AM courses delivered within the Higher Education sector nationally and internationally, and the research interests of those universities in the field of asset management.

### 5 Acknowledgements

The authors would like to acknowledge the input of:

1. The Faculty of Engineering at the University of Bristol;
2. Members of the Institute of Asset Management for their support and guidance in helping us design the new Unit; and,
3. Representatives from major Asset Management organisations who have agreed to help the University deliver the Unit in 2015.

### Table 1: Mapping of the AM Unit design against the IAM’s Competencies Framework

<table>
<thead>
<tr>
<th>IAM Competences Role</th>
<th>Unit Subject</th>
<th>Delivery</th>
<th>Group Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Purpose of Asset Management</td>
<td>Principles of AM</td>
<td>2 lectures by Industry Experts, industry case studies</td>
<td></td>
</tr>
<tr>
<td>Policy Development, Strategy development, Asset Management Planning</td>
<td>Asset Planning and Management; Asset Investment Decision Making</td>
<td>4 lectures by Industry Experts and Academics, industry case studies</td>
<td></td>
</tr>
<tr>
<td>Implementing Asset Management Plans</td>
<td>Life cycle management; Creation and Disposal of Assets; Asset deterioration and failure modes</td>
<td>4 lectures by Industry Experts, industry case studies</td>
<td>Team based project involving critical analysis of 2 asset management plans and potentially the use of IAM’s SAM tool or other diagnostic and assessment techniques.</td>
</tr>
<tr>
<td>Asset Management Capability Development</td>
<td>Creating and sustaining and asset management culture</td>
<td>2 lectures by Industry Experts and academics, industry case studies</td>
<td></td>
</tr>
<tr>
<td>Risk management and performance Improvement</td>
<td>Risks in Managing Assets; Asset deterioration and failure modes</td>
<td>2 lectures by Industry Experts and academics, industry case studies</td>
<td></td>
</tr>
<tr>
<td>Asset Knowledge Management</td>
<td>Asset Management Information Systems</td>
<td>1 lecture by Academics, computer lab, industry case studies</td>
<td></td>
</tr>
</tbody>
</table>

### References


[13] The Russell Group represents 24 leading UK universities, see http://www.russellgroup.ac.uk/


